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EFFECT OF COGNITIVE APPRENTICESHIP INSTRUCTIONAL METHOD ON ACADEMIC ACHIEVEMENT OF MOTOR VEHICLE MECHANICS' WORK STUDENTS IN TECHNICAL COLLEGES IN ANAMBRA STATE

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Abstract
The study investigated the effect of cognitive apprenticeship instructional method on motor vehicle mechanics' work (MVMW) students in technical colleges in Anambra State. A quasi-experimental pretest posttest non-equivalent research design was adopted for the study. The population consisted of 328 NTC II MVMW students and a sample size of 73 using purposive sampling technique. The instrument data collection was a Motor Vehicle Mechanics' Work Achievement Test (MVMWAT) validated by three experts in MVMW and measurement and evaluation. A reliability coefficient of 0.74 of the MVMWAT was found using Kuder-Richardson 21 (K-R21) formula. Two research questions and two hypotheses guided the study. Mean and standard deviation were used to answer the research questions while the analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. Findings from the study among others revealed that the cognitive apprenticeship instructional method significantly improved students' academic achievement more than the demonstration method. It was therefore recommended that cognitive apprenticeship should be adopted as a preferred teaching method among other recommendations with a view to improve students' academic performance.
Keywords: *Motor Vehicle Mechanics' Work, Cognitive Apprenticeship, Demonstration Method, Academic Achievement, and Technical College*

Introduction

The motor vehicle is a self-propelled, non-rail borne, wheeled machinery used for the transportation of people or goods on roads typically powered by an engine or a motor thereby easing means of living within the globe (National Environmental (Motor Vehicle and Miscellaneous Assembly) Regulations 2013). In Nigeria, a motor vehicle is generally referred to as a vehicle propelled by mechanical power (other than one running on rails) and includes vehicles like motorcycles, cars, buses, and even mechanically propelled tricycles. (Ebele, 2013).

Over the years, the motor vehicles have made it possible for man to commute safely and faster within and outside his environment. This machine has undergone rapid and tremendous changes: from horse driven, to mechanically driven and to a more sophisticated electronic driven, featuring robust and powerful engines; automatic power transmission with hydraulic fluid; electronic control systems; improved fuel economy among other innovation. (Abubakar & Abutu, 2019). The presence of motor vehicles has necessitated the provision of road networks, transportation infrastructure, and support services such as fuel stations, repair shops, and parking facilities. This infrastructure supports economic development, enhances connectivity and smooth service delivery in order to meet man's demands.

Issues relating to the motor vehicle repairs and maintenance should not be left to chance, as an ill-maintained motor vehicle can lead to loss of lives and economic resources. When motor vehicles are subjected to various degree of loads and road surfaces, they will often, require maintenance and

repair in order to continue serving its purposes. This unveils the roles and responsibilities of motor vehicle mechanic in ensuring efficient services and maintenance of motor vehicles.

Skilled personnel saddled with the responsibility of repairing and maintaining motor vehicles are known as motor vehicle mechanic (Abubakar & Abutu (2019). They are trained by technical institute either at secondary or tertiary level to be craftsmen, master craftsmen, mechanic or technicians. At the secondary level, technical college is the post basic school level of Nigeria vocational education system, which was established to produce craftsmen and master craftsmen. It is equivalent to senior secondary education but designed to prepare individuals to acquire practical skills, basic scientific knowledge and attitudes required as craftsmen and technicians at sub-professional level (Miller, 2011).

Technical college is an aspect of technical education that provides students with opportunities for the mastery of skills and knowledge in selected occupations as well as for the development of personality for useful living. In order to achieve this goal, technical college curriculum was split into different crafts with corresponding modules so as to enable learners choose and accomplish craft of their interest successfully. One among the various crafts offered at the technical colleges is the motor vehicle mechanics' work craft whose components include auto-body building, repair and spray painting; auto-electrical work; Petrol Engine Maintenance; Diesel Engine Maintenance; Engine Reconditioning; Transmission; Chassis, Suspension Steering and Braking systems; Part Merchandising; Air-conditioning and Service Stations Mechanics. The philosophy of motor vehicle mechanics work programme according to the National Board for Technical Education, (NBTE) (2013) is to produce competent craftsmen and technicians in motor vehicle for Nigeria's technological and industrial development.

Motor vehicle mechanic work as a craft focuses on the repair, maintenance, and servicing of motor vehicles (NBTE, 2013). The field typically provide students with the knowledge and skills required to diagnose, troubleshoot, and fix various mechanical and electrical problems in conventional vehicles and also assemble main units and systems while following manufacturers' specifications. The study exposes learners/students to different systems in a motor vehicle, such as the engine, transmission, brake, suspension, and electrical components.

It is important therefore, that motor vehicle mechanics are equipped with current skills and knowledge to be able to efficiently carry out maintenance work and repair modern highly automated and computerized electronics gadgets in modern vehicles. To achieve these objectives motor vehicle mechanic teachers, need to adopt instructional methods that have strong links to the needs of the workplace. The appropriate teaching and learning of motor vehicle mechanics' work will qualify students for the world of work. It will enhance their academic achievement and as well qualify them for higher educational level that would enable them become knowledgeable in the field of technology. It is against this backdrop that researchers, such as Vincent and Akpan (2014), Amaechi and Thompson (2016) as well as Osuyi and Ainetor (2018), recommend that demonstration teaching method be used for teaching within vocational education community.

In demonstration teaching method, according to Dorgu (2015), the role of the teacher is to illustrate how to do something or illustrate a principle first by explaining the nature of the act verbally, followed by demonstrating the act in a systematic manner and later the students repeat the act. Demonstration is useful mostly in imparting psychomotor skills and lessons that require practical knowledge. The gains of using demonstration method in teaching lies in the fact that it bridges the gap between theory and practice, enables learners to become good observers and generate their interest; students see immediate progress as a result of a correct effort and it enables the teacher to teach manipulative and operational skills.

Although the demonstration method is a wonderful way to explain things to students and is based on behavioral learning theories which emphasis knowledge transmission from the teacher to passive students, it however seems not to be yielding the desired result in motor vehicle mechanics' work craft in technical colleges in Anambra state. This is because there is still persistent failure rate among technical college students. This is a challenge which necessitates the investigation of the use of another instructional method like the cognitive apprenticeship instructional model (CAIM).

The cognitive-apprenticeship instructional method propounded by Collins, Brown, and Newman in Onwusa and Nwaosa (2020) is a process that combines elements of instructional method

and traditional apprenticeship by which learners learn from a more experienced person through cognitive and metacognitive skills and processes. It involves the tacit process of learning undecipherable actions and on-the-job learning. Simply put, it is a process through which a more experienced person assists a less experienced one, providing support and examples, so that the less experienced person gains new knowledge and skills. This method is founded in traditional apprenticeship programs, where daughters and sons learned life sustaining skills from parents/elders which were central to their successes. However, apprenticeship programs have been formalized in many vocational education programs, and that the educational value is not limited to learning psychomotor skills or vocational trades, but support cognitive and metacognitive learning processes.

Traditional apprenticeships have three primary components-modeling, coaching, and fading-utilized as a master craftsman models real world activities in a sequence geared to fit the apprentice's level of ability. The master models expert behaviour by demonstrating how to do a task while explaining why it is being done that way. The apprentice observes the master, and copies his/her actions on a similar task, with the master coaching the apprentice through the task by providing hints and corrective feedback. As the apprentice becomes more skilled in the task, the master assigns more authority to the apprentice by "fading" into the background. In addition to the component of cognitive apprenticeship are reflection, articulation and exploration where learners verbalize the results of their reflection, forms and tests their own hypotheses (Onwusa & Nwaosa, 2020). In modeling the instructor sets the example, guides the students in coaching, and offers feedbacks and hints to students. While in articulation, students articulate their knowledge and problem-solving process, compare their own problem-solving process with that of the teachers in reflection, and try to solve their own problems in exploration. No matter which aspect of the CAIM component that is used, students will ultimately have to practice the task on their own after practicing with the teacher, using materials clearly provided by the teacher and imitating the teacher's actions to complete the task themselves.

The motor vehicle mechanics work craft, being a practical oriented subjects requires that learners be exposed to opportunities that would enable them to see the subtle and tacit elements of expert practice that may not otherwise be explicit in a demonstration instructional delivery. What seems to be unique in this method according to Vanessa and Kerry (2014) is that it sufficiently enables the learner to concretize phenomena through personal interpretation of experience which could enhance their academic achievement.

Academic achievement represents the outcome that indicates the extent to which a person has accomplished specific goals that were the focus of activities in instructional environments, specifically in schools. Tella (2010) posited that academic achievement is used to measure student's success in educational institutions or how well students meet standard set out by examining bodies or the institution. Akinbobo;a (2015) contended that a student's academic achievement is dependent on several factors such as, learning environment, instructional methods and teaching strategy, teachers' attitude and enthusiasm. Among these factors, the instructional method used by teachers, challenge students to work at higher intellectual level that would improve their academic achievement.

The implication of this is that teachers in technical colleges should develop and employ instructional methods that should encourage learners to participate actively in the learning process. Teachers should promote instructional methods which could bring about improved relationship and interaction among students and their teachers. It is therefore hoped that when these are achieved, it would challenge students to work at a higher intellectual ability level that would improve their academic achievement. The researcher therefore believes that the use of appropriate instructional method such as CAIM for teaching in motor vehicle mechanics' work can improve the academic achievement among students irrespective of gender.

Purpose of the Study

The study sought to determine: -

1. The academic mean gain from the pretest and post-test mean scores of motor vehicle mechanics' work students taught petrol engine using cognitive apprenticeship and those taught with demonstration method.
2. The gender difference in academic mean gain from the pretest and post-test mean scores of motor vehicle mechanics' work students taught petrol engine using cognitive apprenticeship and those taught with demonstration method.

Research Questions

The following research questions guided the study.

1. What is the academic mean gain from the pretest and post-test mean scores of motor vehicle mechanics work students taught petrol engine using cognitive apprenticeship and those taught with demonstration method?
2. What is the gender difference in academic mean gain from the pretest and post-test mean scores of motor vehicle mechanics work students taught petrol engine using cognitive apprenticeship and those taught with demonstration method?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance:

1. There is no significant difference in the academic mean gain from the pretest and post-test scores of motor vehicle mechanics work students between those taught petrol engine using cognitive apprenticeship and those taught with demonstration method.
2. There is no significant gender difference in the academic mean gain from the pretest and post-test mean scores of motor vehicle mechanics work students taught petrol engine using cognitive apprenticeship and those taught with demonstration method.

Methods

The study adopted the quasi- experimental design. Specifically, the pre-test and post-test designs with experimental and non-equivalent control groups were used. The area of the study were sixteen technical colleges in Anambra State offering MVMW with a population of 328 NTC II students (306 males and 22 females)

The sample size consisted of 73 NTC II MVMW students (67 male and 6 female) using the purposive sampling technique from two schools out of the sixteen technical colleges that form the study population. The purposive sampling was based on the number of male and female students offering motor vehicle mechanics' work, availability of professionally qualified staff, instructional facilities, geographical spread of the schools and commercial/vehicular activities. Two intact classes were used as the experimental and control groups with each class having both male and female students. Hence, 29 students (25 males and 4 females) from Nigeria Science and Technical College, Nnewi constituted the experimental group, while 44 students (42 males and 2 females) from Government Technical College Onitsha formed the control group

The instruments used for data collection were the Motor Vehicle Mechanics' Work Achievement Test (MVMWAT), cognitive apprenticeship lesson plans and the demonstration lesson plans. The cognitive apprenticeship instructional lesson plans constituted the treatment that was given to the experimental group while the traditional lesson plans were used to teach the control group. There were 40 achievement test items, 20 items were used for the pre-test, while the remaining 20 items were used for the post-test. Three experts from the Department of Industrial and Technology Education, and Department of Education Foundation all from Nnamdi Azikiwe University carried out the content and face validation of the instruments respectively. The reliability of the instrument was determined using Kuder – Richardson 21 (K-R21) formula. This is because the test items were dichotomously scored. Nworgu (2015) explained that K-R21 is a method of rational equivalence for estimating a test's internal consistency usually used when items are dichotomously scored. The reliability coefficient of 0.74 was obtained.

The instrument for data collection was administered to both groups before the experiment as pre-test. Afterward, the same items of the instrument were shuffled, printed with a different font size

and style and then re-administered to both groups as post-test after four weeks which marks the end of the treatment. The motor vehicle mechanics' work teachers involved in the study, then hand in the answer scripts to the researcher, who then mark and analyze the data.

The mean and standard deviation was used to analyze data to answer the research questions while the analysis of covariance (ANCOVA) was used for testing the null hypotheses at a significance level of 0.05. Since the research involves pre-test and post-test of intact classes, ANCOVA was adopted for analyzing the hypotheses to enable the researcher adjust initial group differences (Non-equivalence). Using ANCOVA helped to compare the mean of the two groups.

The decision rule was taken as; If F-calculated (F-cal) is less than or equals the F-critical (F-crit), do not reject Ho while if F-cal is greater than F-crit, reject Ho.

Summarily, any group with higher mean value irrespective of the closeness in the mean value of the other group would be taken to have performed better in achievement test than the other group. Thus, if the significance of F is less than 0.05, the null hypothesis should be rejected and if the significance of F is greater than 0.05, the null hypothesis should be accepted.

Results

Research Question 1. What is the academic mean gain from the pretest and post-test mean scores of motor vehicle mechanics work students taught petrol engine using cognitive apprenticeship and those taught with demonstration method?

Table 1. Difference in Mean Academic Mean Gain between the Experimental Group and the Control Group

	Pretest		**Post-test**		**Mean**	**Mean Gain**
Group	Mean	SD	Mean	SD	Gain	Difference
Experimental	19.11	2.115	30.32	2.186	11.21	5.75
Control	19.34	2.365	24.76	3.632	5.46	
Mean Difference	0.22		5.56			

Table 1 shows the academic mean gain scores from pretest and post-test mean scores of motor vehicle mechanics work students taught petrol engine using cognitive apprenticeship and those taught with demonstration method. The table reveal pretest mean score (M = 19.11) and post-test mean score (M = 30.32) with a mean gain of 11.21 for the experimental group (those taught with cognitive apprenticeship instructional method). The table also shows pretest mean score (M = 19.34) and post-test mean score (M = 24.76) with a mean gain of 5.46 for the control group (those taught with demonstration method). The difference in mean gain of 5.75 reveals those taught petrol engine with cognitive apprenticeship instructional method has higher mean gain than those taught with demonstration method.

Research Question 2. What is the gender difference in academic mean gain from the pretest and post-test mean scores of motor vehicle mechanics work students taught petrol engine using cognitive apprenticeship and those taught with demonstration method?

Table 2. Gender Difference in Academic Mean Gain of Motor Vehicle Mechanic Motor Students

	Pretest		**Post-test**		**Mean**	**Mean Gain**
Gender	Mean	SD	Mean	SD	Gain	Difference
Male	19.16	2.256	28.22	3.903	9.06	1.73
Female	19.50	1.643	26.83	4.446	7.33	
	0.34		1.32			

Data presented in table 2 shows the gender difference in academic mean gain scores from pretest and post-test mean scores of motor vehicle mechanics work students taught petrol engine using cognitive apprenticeship and those taught with demonstration method. The table reveal pretest mean score (M = 19.16) and post-test mean score (M = 28.22) with a mean gain of 9.06 for the male participants. The table further shows pretest mean score (M = 19.50) and post-test mean score (M =

26.83) with a mean gain of 7.33 for the female participants. The difference in mean gain of 1.73 reveals male participants has higher mean gain than the female participants.

Test of Statistical Significance of Hypotheses

Hypothesis 1. There is no significant difference in the academic mean gain from the pretest and post-test scores of motor vehicle mechanics work students between those taught petrol engine using cognitive apprenticeship and those taught with demonstration method.

Table 3. The ANCOVA Result on the Difference in Mean Scores between Experimental and Control Group

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	572.356[a]	2	286.178	36.908	0.000	0.513
Intercept	438.810	1	438.810	56.593	0.000	0.447
Pretest	32.089	1	32.089	4.138	0.046	0.056
Group	552.500	1	552.500	71.255	0.000	0.504
Error	542.767	70	7.754			
Total	58796.000	73				
Corrected Total	1115.123	72				

In Table 3, the results show that the mean difference between the students taught petrol engine using cognitive apprenticeship instructional method and those taught using demonstration method is statistically significant: $F(2, 70) = 71.255$, $p = .000$, p= 0.504. This implies that the null hypothesis is rejected. Hence, there is a significant difference in the academic mean gain from the pretest and post-test scores of motor vehicle mechanics work students between those taught petrol engine using cognitive apprenticeship and those taught with demonstration method.

Hypothesis 2. There is no significant gender difference in the academic mean gain from the pretest and post-test mean scores of motor vehicle mechanics work students taught petrol engine using cognitive apprenticeship and those taught with demonstration method.

Table 4. The ANCOVA Result on the Difference in Mean Scores based on Gender

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	31.727[a]	2	15.864	1.025	0.364	0.028
Intercept	464.909	1	464.909	30.039	0.000	0.300
Pretest	21.079	1	21.079	1.362	0.247	0.019
Gender	11.870	1	11.870	0.767	0.384	0.011
Error	1083.396	70	15.477			
Total	58796.000	73				
Corrected Total	1115.123	72				

Table 4 shows that the mean difference between male and female students taught petrol engine using cognitive apprenticeship instructional method and those taught using demonstration method is not statistically significant: $F(2, 70) = .767$, $p = 0.384$. This implies that the null hypothesis is rejected. Hence, there is no significant gender difference in the academic mean gain from the pretest and post-test mean scores of motor vehicle mechanics work students taught petrol engine using cognitive apprenticeship and those taught with demonstration method.

Discussion

The discussion of the findings are presented as follows.

Effect of Cognitive Apprenticeship Instructional Method on Motor Vehicle Mechanics Work Students Academic Achievement

The finding that students taught petrol engine through the cognitive apprenticeship instructional method achieved higher academic performance than those taught through the traditional demonstration method highlights the importance of active, situated learning. This could be as a result of activities that were incorporated in cognitive apprenticeship which emphasizes modeling, coaching, scaffolding, and gradual transfer of responsibility, allowing students to engage deeply with real-world problem-solving processes. This result is in line with the findings of Kwami and Manabete, (2022), Kumazhege and Umar, (2020), and Abubakar and Abutu, (2019) which reported that cognitive apprenticeship instructional method supports learners in understanding not only *what* to do but *why* and *how* experts make decisions. In contrast, the demonstration method often positions students as passive observers, offering limited opportunities for hands-on practice, reflection, or guided exploration. As a result, students exposed to cognitive apprenticeship are more likely to develop stronger conceptual understanding, practical competence, and confidence in applying their knowledge.

The significant difference between the two groups further reinforces that the cognitive apprenticeship instructional method plays a critical role in shaping learning outcomes in technical and vocational subjects. It suggests that when teaching complex mechanical concepts such as petrol engine operation, strategies that promote collaboration, mentorship, and cognitive engagement yield more effective results than purely teacher-centered techniques. This difference also implies that traditional demonstration, while useful for introducing procedures, may not sufficiently support deeper learning. Therefore, incorporating cognitive apprenticeship principles into technical education curricula could enhance students' mastery, better prepare them for real-world tasks, and ultimately improve overall academic achievement in engineering and technology programs.

The finding that students taught petrol engine through the cognitive apprenticeship instructional method achieved higher academic performance than those taught through the traditional demonstration method differ with the findings of Onwusa, and Nwaosa (2020) which reported that though, cognitive apprenticeship instructional techniques was more effective in improving students' achievement but with high significant difference in favour of boys. This could be due to the fact that both studies were conducted in different geographical and commercial location with population from different socio-cultural background.

Effect of Cognitive Apprenticeship Instructional Method on Male and Female Students Academic Achievement in Motor Vehicle Mechanics Work.

The finding on the gender difference in the academic mean gain of motor vehicle mechanics work students taught petrol engine, whether through cognitive apprenticeship or the demonstration method, suggests that male and female students did not benefit from the instructional approaches in exactly the same way. Differences in learning gains could arise from varying levels of prior exposure, confidence, interest, or learning preferences commonly observed in technical and vocational fields. However, the fact that both instructional methods produced comparable patterns of performance across genders indicates that neither approach inherently favours one gender over the other. This reflects positively on the inclusive potential of both teaching strategies.

More importantly, the result showing that the observed gender difference is not statistically significant implies that the disparity in mean gain is too small to conclude that gender meaningfully influenced learning outcomes. In practical terms, both male and female students benefited similarly from the instructional approaches, and any observed differences could be attributed to chance rather than real instructional or gender-related effects. This result is in line with the findings of Eze, et al (2016), Olaoye and Adu (2015) and Odagboyi (2015), which reports that well-structured instructional methods such as cognitive apprenticeship and demonstration, can provide equitable learning opportunities in technical subjects like motor vehicle mechanics work, reinforcing the importance of pedagogy over gender as a determinant of student achievement.

However, the findings differed with the findings of Igbo et al (2015) which reports that gender has a relevant effect in academic achievement. Their findings showed that male students performed significantly better than the female students in technology related subjects. In another vein,

Okeke (2021), observed that female students do better than the male counterparts in technological subject when exposed to the same learning conditions and that the perceived gender differences in learning are not innate. He associated the differences to gender-stereotypic curriculum and instruction which is a reflection of the society's aspiration in favour of the male.

Conclusion

The findings indicate that the cognitive apprenticeship instructional method significantly enhances students' academic achievement more than the conventional demonstration approach, demonstrating its strong positive impact on learning outcomes. Gender do not significantly influence academic achievement which suggests that students of different gender benefit from the cognitive apprenticeship method in distinct ways. Overall, these results highlight the effectiveness of cognitive apprenticeship as an inclusive yet responsive instructional strategy that improves achievement across groups while offering particular advantages depending on learners' gender.

Implications of the Findings

1. Since the *cognitive apprenticeship instructional method* significantly outperforms the demonstration method in promoting students' academic achievement, educators and curriculum developers should prioritize integrating cognitive-apprenticeship strategies. This implies that teacher-training programs must emphasize cognitive apprenticeship as an evidence-based pedagogical approach capable of improving learning outcomes across subjects.

2. The absence of significant gender differences in achievement under both instructional methods suggests that cognitive apprenticeship is an equitable teaching approach that supports students regardless of gender. This implies that interventions aimed at reducing gender gaps in learning may benefit more from focusing on instructional quality rather than gender-specific adjustments.

Recommendations

The following recommendations were made based on the findings of the study.

1. Curriculum planners and school administrators should prioritize the integration of cognitive apprenticeship strategies into lesson plans to enhance learning outcomes, since the cognitive apprenticeship instructional method has effect on students' academic achievement compared to the demonstration method,

2. Technical education teachers should employ teaching strategies that are inclusive and equitable, without differentiating instruction based on gender given that gender does not significantly influence academic achievement in either teaching method.

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